

## **LAND COVER CHANGE PROBLEM: MATH LESSON ON SCALING (% change)**

Intermediate-Advanced Level

### **Purpose**

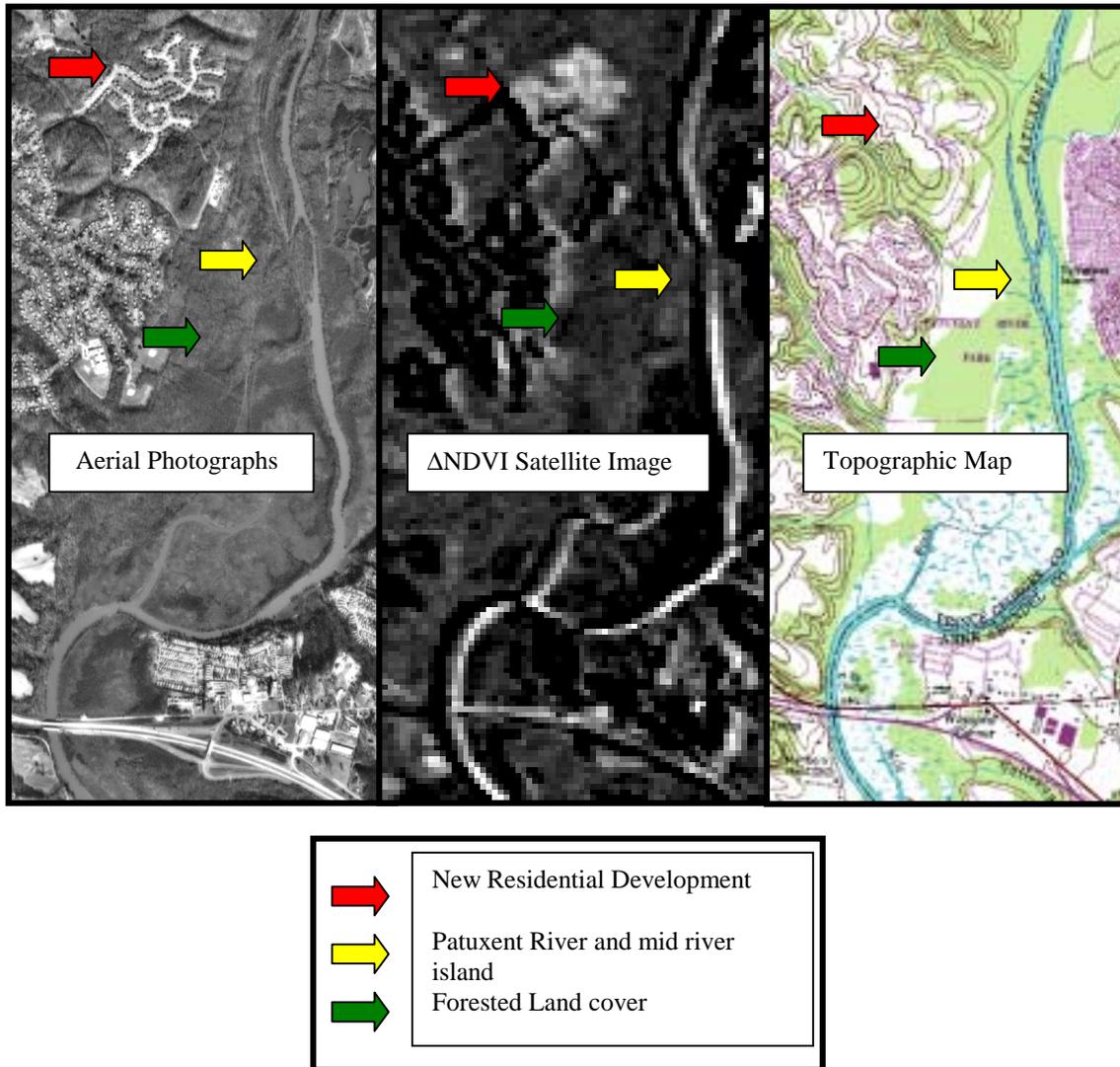
To create, scale and read maps to help interpret various  $\Delta$ NDVI images. Part of this is to create a photo/image interpretation selective key to help interpret the aerial photograph of the study area.

### **Background Information**

The end product of this lesson is to create map overlays that can help interpret the  $\Delta$ NDVI image. In a satellite images only the large roads are visible. When the students find an area of change shown in the  $\Delta$ NDVI image that is not on or near a major road, trying to accurately identify this area can be very difficult. Even when a roadmap or a topographic map are used side by side to help identify students still misidentify areas due to differences in the scale of the two images. To help make the identification process easier this lesson shows students how to rescale a map to the same scale as the satellite image. A couple of interesting things are possible with a map that is rescaled to the satellite image. First and foremost the map can be transferred to a transparency using a copier and then overlaid on the satellite image. Additionally, the scale of the satellite image can be calculated using the percent needed to change the map and the original map scale. This last possibility is easily checked due to the fact that Landsat images have a standard pixel size of 28.5 meters by 28.5 meters.

Aerial photographs are used to determine what areas of this image have change and why without leaving the classroom. This is basically a set of areas on the aerial photograph that the students confidently identify using collateral material or metadata. The metadata can be maps, graphs, or images. "Some authors say that as a general rule, keys are more easily constructed and used for the identification of man-made objects and features than for natural vegetation and landforms...Basically, an interpretation key helps the interpreter organize the information present in the image form and guides him/her to the correct

identification of unknown objects.” ([Aids to and Techniques of Image Interpretation](#)) The students will need to construct a simple key so they can figure out what type of change has occurred in what area of the  $\Delta$ NDVI image. In this case we will primarily use a U.S. Geologic Survey Topographic Quadrangle mosaic that was last revised in 1976 for the collateral material or metadata.



MLS Figure 1. The above set of images and maps illustrates how different data sets can work together to aid in the interpretation of the  $\Delta$ NDVI image. In the selected area, a section of the Patuxent River, there are three different features that can be easily identified using the aerial photograph.

Before we can even begin this task a couple of things need to happen. All the maps need to be scaled to the same scale so that they can be compared and or overlaid over each other. This is a process that will require the students to compute the scale for images, satellite images, which do not have scales provided. This will test their map reading and critical thinking skills. The below flow chart will graphically shown why these lessons are grouped together.

## **Time**

- 1-2 class periods to create the needed images.
- Time out of class can be used for the data analysis.

## **Level**

Intermediate and Advanced

## **Key Concepts**

Communication skills

Read and understand images produced by others

Produce images for other to interpret

Find and describe locations on maps and computer-generated images

Technology/Software Mastery

Use computer software to scale images

Use computer software to interpret images

Computation and Estimation

Use, interpret, and compare numbers

Estimate distances from maps and actual sizes of objects from scale drawings

Decide what degree of precision is adequate

Critical-Response

Be aware that there may be more than one good way to interpret a given set of findings

## **Skills/Students will:**

- understand the different data that can be determined from each image
- (understand that the significance of a change is based on the original size)\*
- use proportions to change a ratio to a percent
- use percents to describe increase/decrease in an image

## **Prerequisites:**

Students should

- understand the concept of a scale on a map
- be familiar with the process of solving proportions to find equal ratios

## **Materials:**

- Landsat  $\Delta$ NDVI images
- Aerial photograph of the same area
- Topographic map of the same area
- Student worksheet
- Calculator
- Metric Ruler
- Copier that can enlarge and reduce images
- Computer with internet access and a color printer

- Transparencies that are copier safe
- Overhead Projector
- Permanent Marker, ultra fine point

## Preparation

- Download the appropriate images and print them on a color printer
- Copy images and maps on to transparencies
- Find a prominent intersection. Mark the intersection on all 3 images with a dot.
- Put the students into groups of 3 or 4.

## Procedure

1. Give each group a scaling packet, metric ruler, aerial photograph,  $\Delta$ NDVI images and topographic map of the same area.
2. Each student should have one image he/she is in charge of- the fourth student can be the checker.
3. The following questions will help familiarize your students with their images as well as the purpose of this lesson. Each question should be discussed with the class. Be sure everyone knows how the images were taken/made.
4. Ask everyone in the group to look at the NDVI image. “Can you tell what everything is? Why or why not?” (taken by a satellite thousands of miles above the Earth)
5. Then ask them to look at the aerial photograph and answer the same questions. (taken by a camera on an airplane in the Earth’s atmosphere)
6. Finally, have them look at the topographic map and answer the same questions. (made by map makers who have visited the areas)
7. The students should come to the conclusion that they can name everything on the topographic map, most things on the photograph, but very little on the NDVI image. So we would like to use the map and the photo to help us identify everything in the NDVI image.
8. The only problem is that the images were taken from very different distances. Therefore each image covers a different amount of space and has a different scale. In other words, a mile in real life is much smaller on the image taken by a satellite than one taken by an airplane.
9. If we enlarge or shrink our images so that the scales were the same size we could lay the transparencies on top of each other and label everything on the NDVI image.
10. The students should now be able to complete numbers one and two. Check each group’s image to make sure they were able to find the same intersection on all three images.
11. The
12. You may need to help students set up and solve their proportions.
13. Unfortunately, the copying machine will not ask you for a distance. When you have a two-dimensional picture (length and width- square centimeters) a one-dimensional measurement (just length- centimeters) is not sufficient.
14. The other reason that a measurement is not very practical is because you cannot use this number to compare how much you had to enlarge or shrink an image. Just imagine if one person were able to jump one and a half feet up in the air and somebody else was able to jump three feet. At first, you might admire the second person’s talent and think the first

person didn't have much talent. But if I told you that the first person was only three feet tall and in second grade and the other person was seven feet tall, the situation might look a little different. The second-grader jumped half, or 50 %, of his height, while the taller person jumped about 43 percent. With percents you can compare the new amount with the original amount.

15. You can compare how much you had to enlarge two different size images. If you would like to increase an image by 100%, you would be doubling its size. If you wanted to increase it by 50 %, your final image would be one and a half times its original size (smaller than double). The percent, which you would like to increase an image, is called the percent of increase. If you were reducing an image, this percent would be called the percent of decrease.

16. Let's take an example.

Images	Distance (in cm) between two dots	Scale (in cm per mile)	Difference between two scales	Ratio	Percent of Increase
Topographic Map	18	$\frac{\text{cm } 18}{\text{mi } 0.5} = \frac{36}{1}$	X	X	X
Aerial Photograph	6	$\frac{\text{cm } 6}{\text{mi } 0.5} = \frac{12}{1}$	24	$\frac{24}{12} = \frac{2}{1}$	200 %
Δ NDVI Image	10	$\frac{\text{cm } 10}{\text{mi } 0.5} = \frac{20}{1}$	16	$\frac{16}{20} = \frac{4}{5}$	80 %

Measure the distance of the dots. Set up a ratio to find the scale of cm per mile. Figure out how many cm you will need to add to each scale to make it equal the largest scale. This will tell you how much you need to increase each image by. Set up another ratio of the amount of cm needed for each image over the original number of cm equivalent to one mile. Finally turn this ratio into a percent for the percent of increase.

17. Note: when entering these percents on a copying machine, be sure to add 100 % to the student's figures since their figure is the percent of increase.

18. Answers to student's practice chart.

Images	Distance (in cm) between two dots	Scale (in cm per mile)	Difference between two images	Ratio	Percent
Topographic Map	13	$\frac{13}{2} = \frac{7.5}{1}$	1.5	$\frac{1.5}{7.5} = \frac{1}{5}$	20 %
Aerial Photograph	9	$\frac{9}{2} = \frac{4.5}{1}$	4.5	$\frac{4.5}{4.5} = \frac{1}{1}$	100 %
Δ NDVI Image	18	$\frac{18}{2} = \frac{9}{1}$	X	X	X

Name \_\_\_\_\_

### Student Packet on Scaling

*Materials:* You will need an aerial photograph, a topographic map, ΔNDVI image (the ΔNDVI image that is from the oldest date to the most recent, most likely the 1984 to 1997) and metric ruler. Make sure you can identify each of these images and maps.

Lay out your three images. Find the dot at the intersection of two roads on each image.

1. Look at your topographic map to find another intersection. Mark this intersection with a pen.
2. Find the same intersection on the other two images. Mark these as well.
3. Have your teacher check your three images and then initial here. \_\_\_\_\_
4. Measure the distance (in cm) between the two dots on the topographic map. Fill in the distance in the 1<sup>st</sup> column of the chart below.
5. Measure the distances (in cm) between the two dots on the aerial photograph and the NDVI image. Record them in the 1<sup>st</sup> column on the chart below.

Images	Distance (in cm) between two dots	Scale (in cm per mile)	Difference between two images	Ratio	Percent
Topographic Map					
Aerial Photograph					
Δ NDVI Image					

Here is an example of a completed chart to help you as you answer the following questions.

Images	Distance (in cm) between two dots	Scale (in cm per mile)	Difference between two scales	Ratio	Percent of Increase
Topographic Map	18	$\frac{\text{cm } 18}{\text{mi } 0.5} = \frac{36}{1}$	X	X	X
Aerial Photograph	6	$\frac{\text{cm } 6}{\text{mi } 0.5} = \frac{12}{1}$	24	$\frac{24}{12} = \frac{2}{1}$	200 %
Δ NDVI Image	10	$\frac{\text{cm } 10}{\text{mi } 0.5} = \frac{20}{1}$	16	$\frac{16}{20} = \frac{4}{5}$	80 %

Now we know that the distance between these two points is different on each image/map. However, the distance in real life between these two points is the same. Our next step is to find out the scale for each image. In other words, how many centimeters on the map equals one mile in real life.

5. One of these images already has a printed scale. Which image? Write the scale in centimeters per mile next to the image in column 2. (If the scale is not in cm per mi, write and solve a proportion to find the answer.)
6. Now we need to figure out the scale for each of the other images. Solve the following proportion for each image and write the scale ratio in the proper box in column 2.

$$\frac{\text{Distance on map in cm}}{\text{Distance in real life in mi}} = \frac{?}{1} \qquad \qquad \qquad \frac{\quad}{\quad} = \frac{?}{1}$$

7. Put a star on the chart by the image that has the largest scale. You can tell which image has the largest scale by looking at how far apart your two dots are. The image that has the most centimeters for each actual mile has the largest scale. We will call this image your target image. Put an x in each empty box across from your target image.

Now, we need to enlarge the other two images on a copying machine until all three scales are the same size. The question is how much do we need to enlarge it. Our answer will need to be in a percent.

8. Subtract the scale (centimeters equivalent to one mile) from one image (recorded in the 2<sup>nd</sup> column) from the scale on your target image (also recorded in the 2<sup>nd</sup> column). Record your answer in the third column. Do the same for the last empty box in column three.
9. Fill in column four with the ratios of the difference (column 3) to the scale (number of centimeters equivalent to one mile). Be sure to simplify.
10. In the space below, change these two ratios to percents using proportions. Record your answers in the last column of your chart.

These percents are the percent you would like your images to be increased. Write the percent that goes with each of your two images and your name on a piece of sticky paper. Attach each percent to the proper image. Give these images to your teacher so that she can enlarge them the proper amount. While you are waiting, finish the following chart. By checking these answers, you should have a good idea if you filled in your chart correctly.

Images	Distance (in cm) between two dots	Scale (in cm per mile)	Difference between two images	Ratio	Percent
Topographic Map	13				
Aerial Photograph	9				
$\Delta$ NDVI Image	18				